

Protecting the Nation's Livestock: Corralling Foreign Diseases

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Highlights of today's presentation

- The diversity of careers in veterinary medicine
- How infectious disease spreads
- How to break the cycle of disease spread for people and animals
- How computer models are used to study diseases
- Why rapid, accurate, cost-effective diagnostic tests are important in disease control

What does a veterinarian do?



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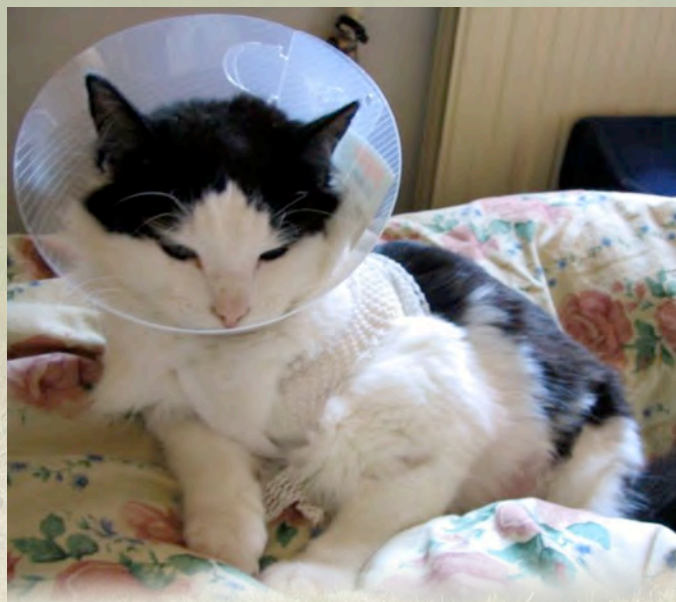
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What does a veterinarian do?



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What does a veterinarian do?



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What does a veterinarian do?



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What do veterinarians do?



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What does a veterinarian do?



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What does a veterinarian do?



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International veterinary relief projects benefit both animals and people



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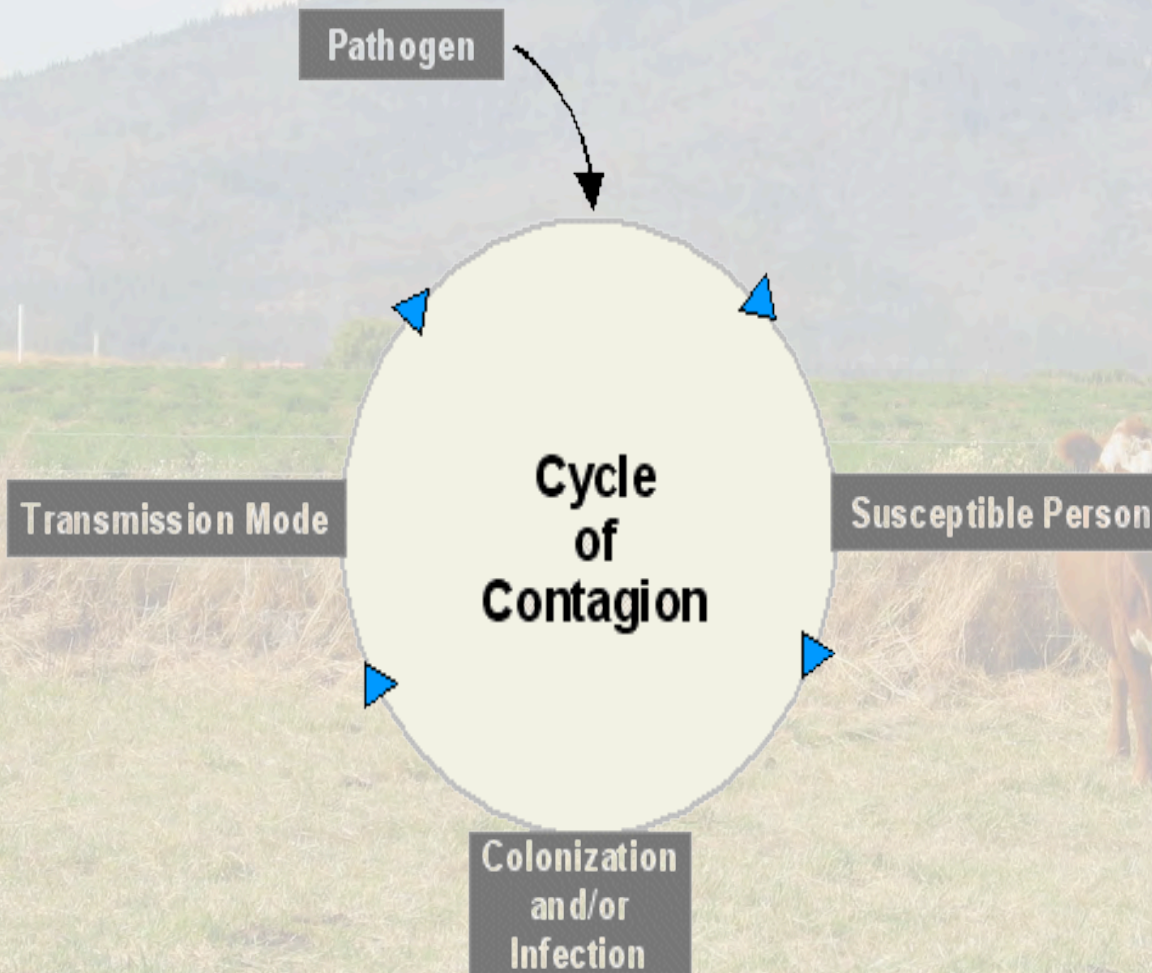
What does it take to become a veterinarian?

- Strong interest in science
- Interest in working with animals
- Strong academic performance
- Veterinary related work experience
- 2 + years of undergraduate education
- 4 years of veterinary school
 - 27 schools in the US
- State (some) and Federal licensing exams



- Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response:
 - Students know the role of the skin in providing nonspecific defenses against infection.
 - Students know the role of antibodies in the body's response to infection.
 - Students know how vaccination protects an individual from infectious diseases.
 - Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.

Here come the microbes... are you ready?



The Cycle of Contagion

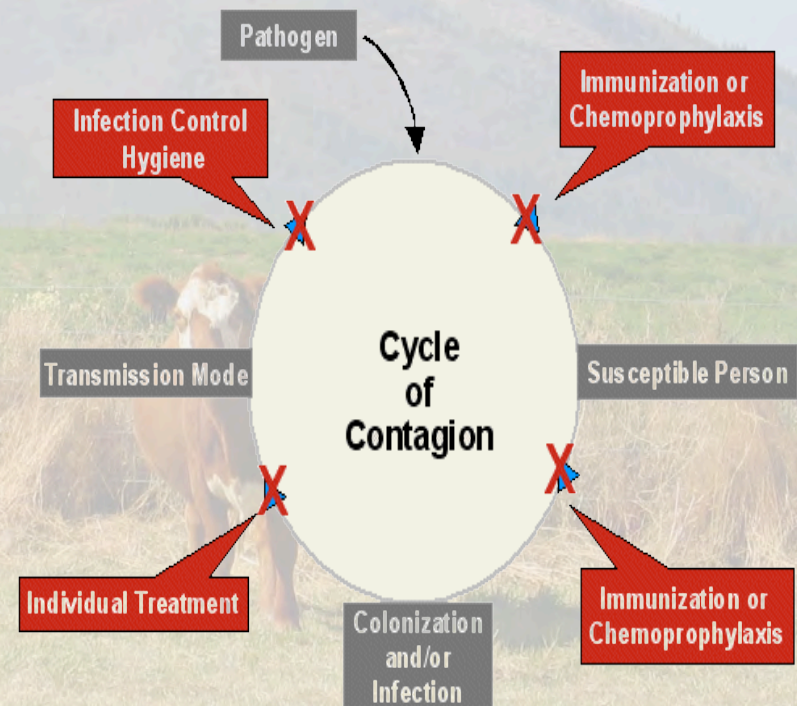
- The cycle of contagion begins when a disease-causing agent or *pathogen* — such as a virus or bacteria — finds its way onto or into an object, animal, or human.
- The pathogen finds its way to a susceptible person, and that person becomes a *host* for the pathogen.
- The pathogen may multiply in the host without causing injury; this is called *colonization*.
- If the pathogen attacks host tissues, it causes the symptoms of *infection*.

Infection Transmission

- Different infectious illnesses are transmitted in different ways.
- They may be spread by contact, droplet, airborne, common vehicle, or vector (e.g., insects or animals) *modes of transmission*.
- For example, pathogens such as respiratory viruses may be easily transmitted *hand-to-hand* or in *droplet* form.
- Thus, without infection control measures that interrupt these specific modes of transmission, a respiratory infection such as influenza can spread rapidly.

Infection Control

- The purpose of **infection control** is to prevent new infections when possible and to identify new infections and halt their spread whenever prevention is not possible.
- The types of actions that can prevent infections and halt their spread can be identified from the cycle of contagion model.
- The infection control actions include the following:

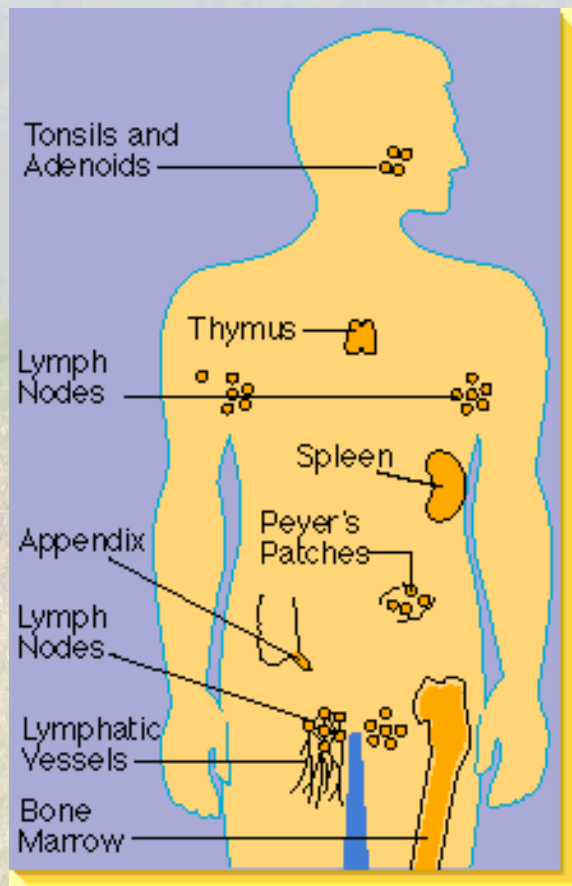


Bacteria vs Virus

- **Bacteria** are microbes (***a microscopic single cell organism***) that can be found virtually anywhere. They are in air, the soil, and water, and in and on plants and animals and humans.
- **Function:** There are ***good*** and ***bad*** bacteria. They have useful functions such as, making vitamins, breaking down garbage, and even maintaining our atmosphere. There are also ***pathogenic*** bacteria.
- **Viruses** consist of a small collection of genetic material (***DNA or RNA***) encased in a protective coat called a ***capsid*** 10,000 x smaller than bacteria.
- When ***viruses*** come into contact with the host cells, they ***trigger*** the cells to ***engulf*** them and ***connect*** themselves so they can release their ***DNA*** into the cell. Once inside a host cell, ***viruses take over*** its ***machinery*** to reproduce; with their ***own*** set of ***instructions*** that shut down the production of the host's ***proteins*** and direct the cell to produce ***viral proteins*** to make ***new*** virus particles.

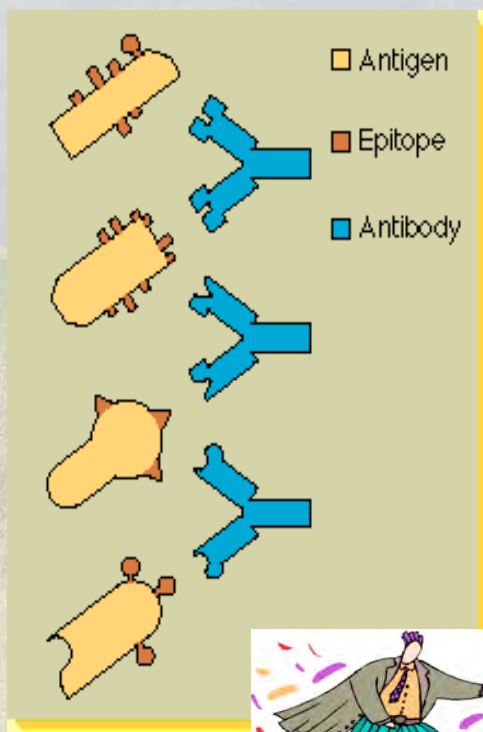
There are NO good viruses. ALL are bad.

The Human Immune System... FANTASTIC



- **Nonspecific disease** protection includes skin, mucous membranes, gastric juices, lymphatic organs (tonsils, adenoids, lymph nodes).
- From the outside to the inside, your body is prepared to launch an attack against microbial invaders.

The Antigen-Antibody Response



- Antigen is a molecule that sometimes stimulates an immune response. Antigens are usually **proteins** or **polysaccharides**.
- This includes parts (coats, capsules, cell walls, flagella, fimbriae, and toxins) of **bacteria**, **viruses**, and other **microorganisms**.
- An epitope is recognized by antibodies or B cells and can be thought of as three-dimensional surface features of an **antigen** molecule; these features fit precisely and thus bind to antibodies.

Mircroorganisms can be tricky

- Sometimes, detection by our immune system is complicated as pathogens adapt and evolve new ways to successfully infect the **host** organism and avoid detection.
- Dr. Hullinger is a veterinarian scientist that is working on improving pathogen detection methods.



So what does a veterinarian do at a national security laboratory?



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At LLNL, the focus is on foreign animal diseases

- Foreign animal disease modeling
 - Run models on super computers to evaluate the potential impact of animal disease events
 - Foot and mouth disease
 - Highly Pathogenic Avian Influenza
 - Classical Swine Fever
 - Exotic Newcastle Disease
- Diagnostic test development
 - Foot and mouth disease
 - Highly Pathogenic Avian Influenza



Why is protecting the nation's food supply important?

EVERYBODY EATS, EVERY DAY



My research is inspired by my experience in the United Kingdom in 2001



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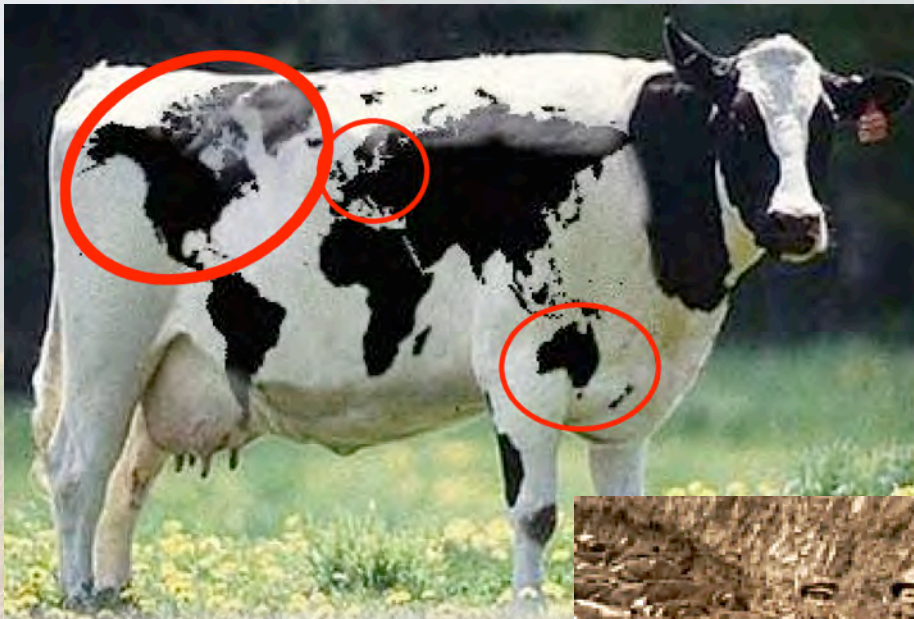
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So, why is foot-and-mouth disease a national security issue?



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The United Kingdom's 2001 outbreak of FMD cost ~ \$ 30 billion



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“The greatest costs of disease can not be quantified”



The Hewsons of Parton Farm

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Usually, the clinical signs of disease
are obvious



The clinical signs of foot and mouth disease can be very dramatic



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Interdigital ulcers

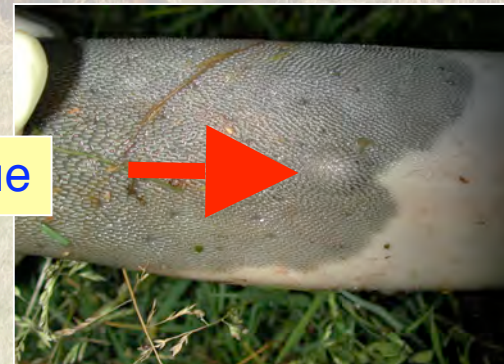


Oral ulcers



Tongue surface sloughing

Blister on the surface of a cow's tongue



All exposed cattle must be destroyed



The daily average of animals slaughtered in the United Kingdom was 9,000-80,000 per day

Slaughter/Disposal Numbers = 10 million livestock (10% of UK total)



01 06 2001

The greatest tragedy is that no one learns from...



In order to prevent disease you must understand the disease triad



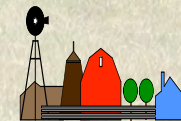
HOST

AGENT



DISEASE

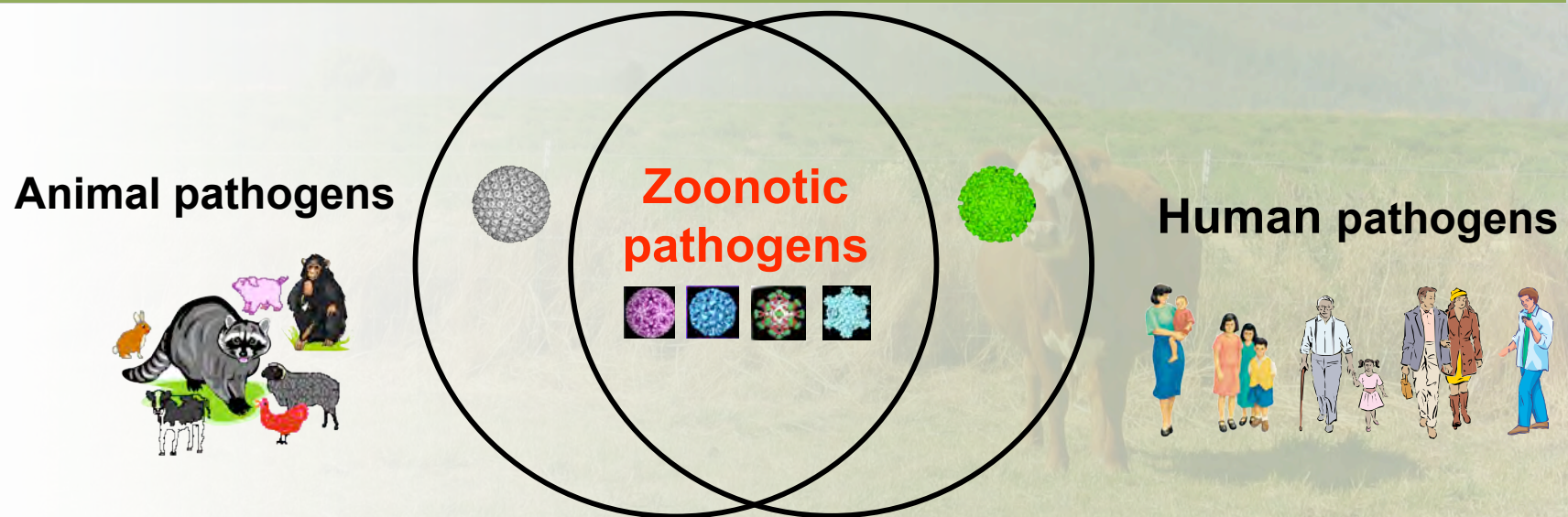
ENVIRONMENT



Most emerging infectious diseases in the 21th century are zoonotic

Zoonotic diseases are diseases or infections that are transmitted between animals and humans

(e.g., Avian influenza, West Nile Virus, Lyme disease, BSE, SARS)



Approximately 70% of known pathogens are shared between animals and humans

Understanding how disease spreads is key to stopping an outbreak

- Disease can spread;
 - Direct contact
 - Indirect (fomite) contact
 - Mud on shoes
 - Dirt on tires
 - Contaminated clothing



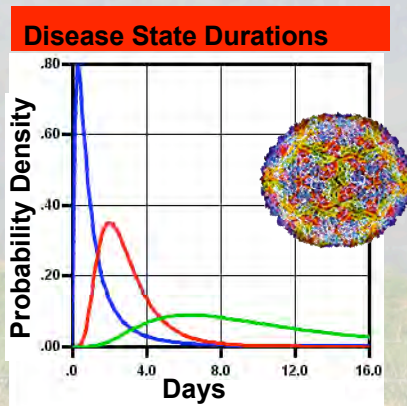
Mud in sole of boot



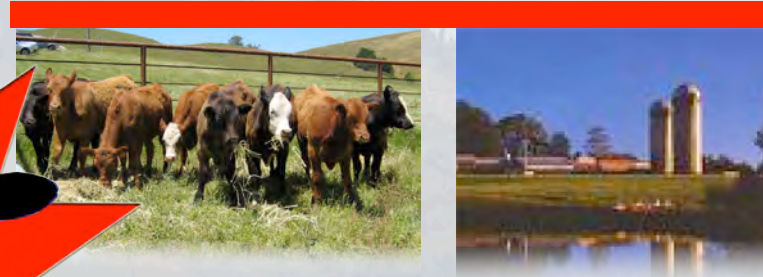
Contaminated mud on highway

An animal disease models have several basic components

The Disease - FMDV



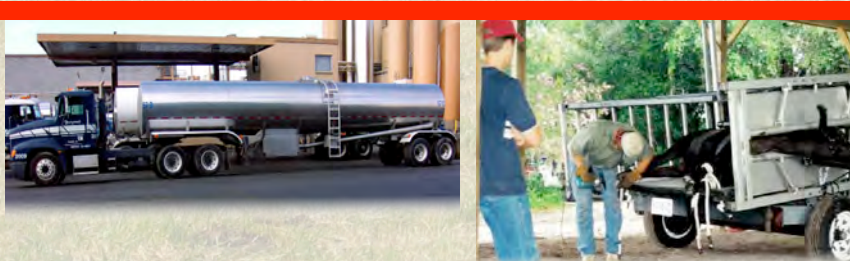
The Premises and Livestock



Economic Impact

Control Measures

Direct and indirect contacts between premises



We use the super computers to study the evolution of
foreign animal diseases



**MULTISCALE
EPIDEMIOLOGIC AND ECONOMIC
SIMULATION
ANALYSIS DECISION SUPPORT SYSTEM**



We also work on developing better diagnostic tests

- Find the first case of FMD, As soon as possible
- Corral-side tests to help on-farm diagnosis
- Provide “field to findings”, scaleable, surge capacity



In the UK, diagnosis of FMD was often difficult



FMD



VSV



FMD



FMD



NOT FMD



FMD

We are developing a rapid, cost effective test to screen for foot and mouth disease

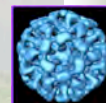
Foot-and-mouth, ss RNA



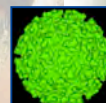
Swine vesicular, ssRNA



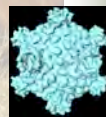
Vesicular exanthema of swine, ssRNA



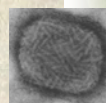
Bovine viral diarrhea, ssRNA



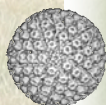
Bluetongue, ds RNA



Parapox-virus complex, DS DNA



Bovine herpes-1 (IBR), ds DNA



Luminix



LUMINIX

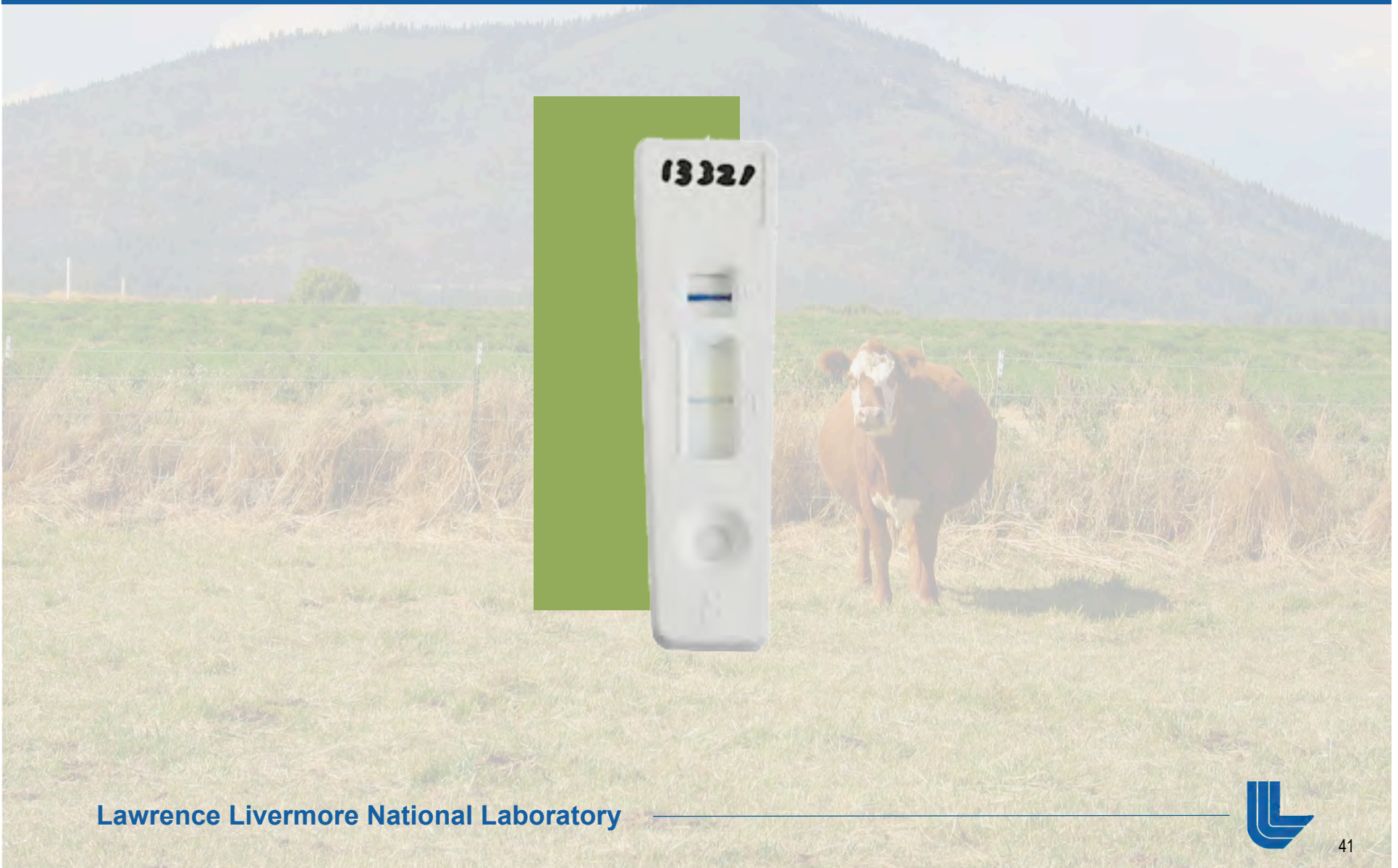
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We are also developing a pen-side test to confirm foot and mouth disease within 30 minutes



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What we hoped you have learned today

- The diversity of careers in veterinary medicine
- How infectious disease spreads
- How to break the cycle of disease spread for people and animals
- How computer models are used to study diseases
- Why rapid, accurate, cost-effective diagnostic tests are important in disease control

Now let's see what you have learned

- Let's play jeopardy....
- The name of diseases shared between animals and people = What is zoonotic
- The name of an inanimate object which can transmit disease = What is a fomite
- A foreign animal disease which has not been in the United States since 1929 = What is FMD